

***RHEOCLES VATOSOA*, A NEW SPECIES OF FRESHWATER RAINBOWFISH (ATHERINOMORPHA: BEDOTIIDAE) FROM THE LOKOHO RIVER BASIN IN NORTHEASTERN MADAGASCAR**

by

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ABSTRACT. - *Rheocles vatosa*, sp. nov., an endemic Madagascan rainbowfish, is described from the Lokoho River basin in the region of Andapa in northeastern Madagascar. *Rheocles vatosa* has the northernmost distribution of the genus recorded to date. The species differs from congeners in the possession of a single (*versus* three) interdorsal pterygiophore and is additionally readily distinguished from the other two “northern species”; *R. pellegrini*, from a locality “one day west of Andapa”, and *R. derhami* from the Ambombo River (Sofia drainage), by the possession of a fully scaled dorsum, nape, and venter.

RÉSUMÉ. - *Rheocles vatosa*, une nouvelle espèce de poisson arc-en-ciel d’eau douce (Atherinomorpha: Bedotiidae) du bassin de la rivière Lokoho, au Nord-Est de Madagascar.

Rheocles vatosa, sp. nov., un poisson arc-en-ciel endémique de Madagascar, est décrit du bassin de la rivière Lokoho dans la région de l’Andapa, au Nord-Est de Madagascar. Cette espèce est actuellement connue comme étant la plus septentrionale du genre. L’espèce diffère de ses congénères par la présence d’un seul (contre trois) ptérygiophore interdorsal et se distingue facilement des deux autres espèces du “groupe septentrional”, *Rheocles pellegrini*, connue seulement d’une localité située à “un jour de marche à pied à l’Ouest d’Andapa”, et *Rheocles derhami*, originaire de la Rivière Ambombo, affluent de la Sofia, par la possession du dos, de la nuque et du ventre complètement recouverts d’écailles.

Key words. - Bedotiidae - *Rheocles* - Madagascar - New species.

The atherinoid family Bedotiidae, endemic to Madagascar, comprises the genera *Bedotia* Regan, 1903 and *Rheocles* Jordan & Hubbs, 1919. *Rheocles* is diagnosed by the derived presence of a consolidated lower hypural fan that incorporates a fully fused parhypural. The genus has been the subject of several recent publications (Stiassny, 1990; Stiassny and Reinthal, 1992; Stiassny and Rodriguez, 2001) and six species have been described. However, as noted by Loisel and Stiassny (in press), a number of undescribed species have recently been discovered and one of these, informally named in that publication *Rheocles* n. sp. “andapa”, is described herein.

Based on four syntypes collected during the Mission Zoologique Franco-Anglo-Américaine to Madagascar (1929-1932), Nichols and LaMonte (1931) described *Rheocloides pellegrini*, from a locality in northeastern Madagascar “One day west of Andapa” (Rand, 1936). In subsequent revisional studies, Stiassny (1990) and Stiassny and Rodriguez (2001) examined three of the type specimens (the fourth cannot be located) of *Rheocloides pellegrini* and placed *Rheocloides* in synonymy with *Rheocles* while retaining “*pellegrini*” as a valid species. *Rheocles pellegrini*

is characterized by a marked reduction in squamation, with the nape, chest and venter completely naked. Aside from the type series, little more is known of *R. pellegrini* and fish collections from the region are sparse (Stiassny and Harrison, 2000). However, recent collections made in the vicinity of the town of Andapa have yielded numerous *Rheocles* specimens, none of which is referable to *R. pellegrini* or to *R. derhami* Stiassny & Rodriguez, 2001, a second *Rheocles* species from the northwestern region of the island (Stiassny and Rodriguez, 2001). The Andapa *Rheocles* are hypothesized to be members of a new species described herein. While the precise provenance of *R. pellegrini* may never be determined, it probably lies in the headwaters of the Antainamabalana drainage rather than the Lokoho basin (see section Distribution and habitat, below).

ABBREVIATIONS AND COMPARATIVE MATERIALS

Institutional abbreviations are: AMNH, American Museum of Natural History, New York; MHNG, Muséum

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d'Histoire Naturelle, Genève; MRSN, Museo Regionale di Scienze Naturali, Torino, Italy; MNHN, Muséum national d'Histoire naturelle, Paris; MRAC, Musée Royal de l'Afrique Centrale, Tervuren; UMMZ, Museum of Zoology, University of Michigan, Ann Arbor.

In addition to the primary types of *R. sikorae* MNHN 1891-727, *R. wrightae* MNHN 1942-77, *R. alaotrensis* MNHN 1913-333, *R. pellegrini* AMNH 9696, AMNH 11699, MNHN 1932-24, *R. lateralis* AMNH 59311, and *R. derhami* AMNH 230358, the following comparative materials have also been examined (numbers in parenthesis after catalogue number indicate number of individuals examined). Alc., alcoholic specimens; c.s., cleared and double stained for bone and cartilage; skel., dry skeleton; rad., radiograph: *Rheocles alaotrensis* AMNH 88001(5) (alc., c.s., rad.), AMNH 88171(2) (alc., c.s.), AMNH 97129(4) (c.s.), MNHN 1913.329-333(4) (rad.), MNHN 1966-1074(1) (rad.), AMNH 231221(5) (alc., c.s.), *Rheocles derhami* AMNH 230359(8) (alc., c.s.); *Rheocles lateralis* AMNH 59312(15) (alc, rad., c.s.), AMNH 97084(2) (alc., rad.); *Rheocles sikorae* MNHN 1966-914(10) (rad.), AMNH 28127(2) (alc, rad.); *Rheocles wrightae* AMNH 228077(10) (alc., rad., c.s.). Counts and measurements follow Stiassny (1990) and Stiassny and Rodriguez (2001).

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(Figs 1-4)

Material

Holotype. - AMNH 231979, male 64.6 mm SL; Madagascar, Marovato creek at Ambodivohitra village, several kilometers north of Marovato village on the road to Ambalamangy, Antsiranana (Diego Suarez) Province,

14°34'95"S, 49°37'74"E, Lokoho River drainage, Andapa basin, altitude 446 m; dipnet over sandy bottom with scattered gravel and organic detritus; 23 Oct., 1999; P.V. Loiselles.

Paratypes. - Total of 60 specimens, 38.1-79.2 mm SL; AMNH 231367, 11, 42.8-71.9 mm SL, same data as holotype; AMNH 231366, 10, 3 c.s., 44.4-58.7 mm SL, Andramonta River at Ambodihiasina village, Antsiranana Province, ca. 100 m southwest of primary school (14°36'06"S, 49°20'21"E), Lokoho drainage, Andapa basin, altitude 476 m, dipnet over rocky bottom, moderate to strong current; 22 Oct., 1999; P.V. Loiselles; AMNH 215502, 6, 40.7-68.2 mm SL, one c.s., Antangena River, a small stream in the Lokoho drainage, Andapa basin, Antsiranana Province, dipnet over sand and rock, 21 Oct., 1994; P. de Rham; AMNH 231254, 8, 38.1-59.6 mm SL, Andrakata stream at Andrakata village, Antsiranana Province (14°37'64"S, 49°43'10"E), Lokoho drainage, altitude 157 m, dipnet in stream over bedrock, gravel and coarse sand, region moderately to severely degraded lowland forest; 12 Oct. 2000, P.V. Loiselles; AMNH 231253, 5, 38.7-47.9 mm SL, Marovatobe Creek, tributary of the Lokoho River, Andapa basin, Antsiranana Province (14°34'85"S, 49°37'84"E), altitude 448 m, degraded forest, 10 Oct. 2000, P.V. Loiselles; MRSN P-1011, 7, 46.0-61.1 mm SL, Betsivakiana River, Amponaomby-Besariaka rainforest, Andapa Fivondronana, Campsite Ambinaninimiaka-midina, Antsiranana Province (14°49'29"S, 49°35'44"E), Lokoho drainage, altitude 940 m, 12 Jun. 1996; F. Andreone; MRSN P-100, 13, 38.9-79.2 mm SL, Betsivakiana River, Amponaomby-Besariaka rainforest, Andapa Fivondronana, Campsite Ambinanin'Antsahamolo-to, Antsiranana Province (14°39'00"S, 49°35'42"E) Lokoho drainage, altitude 850 m, 19 Jun. 1996; F. Andreone; MHNG 2619.56, 2,

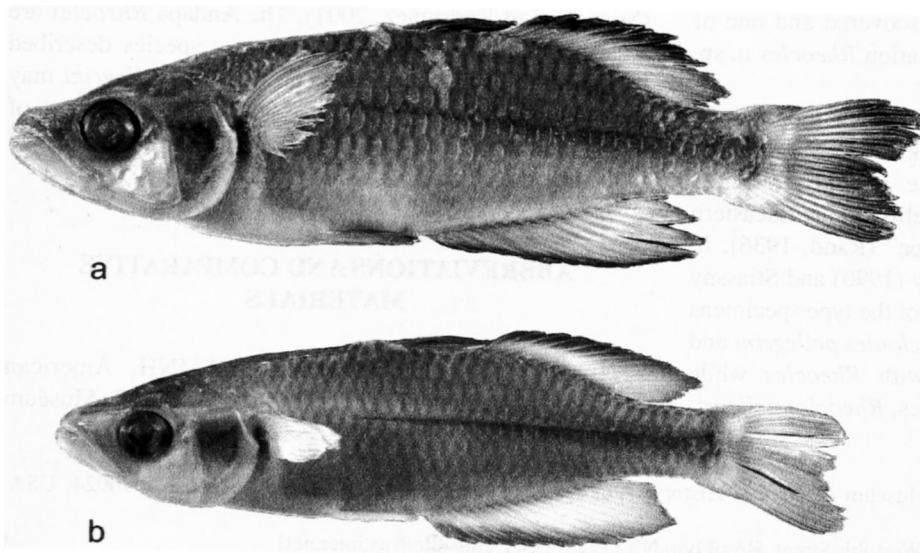


Fig. 1. - Photograph of the holotype of *R. vatosoa*, AMNH 231979, male 64.6 mm SL (a) and paratype, AMNH 231367, female 56.7 mm SL (b).

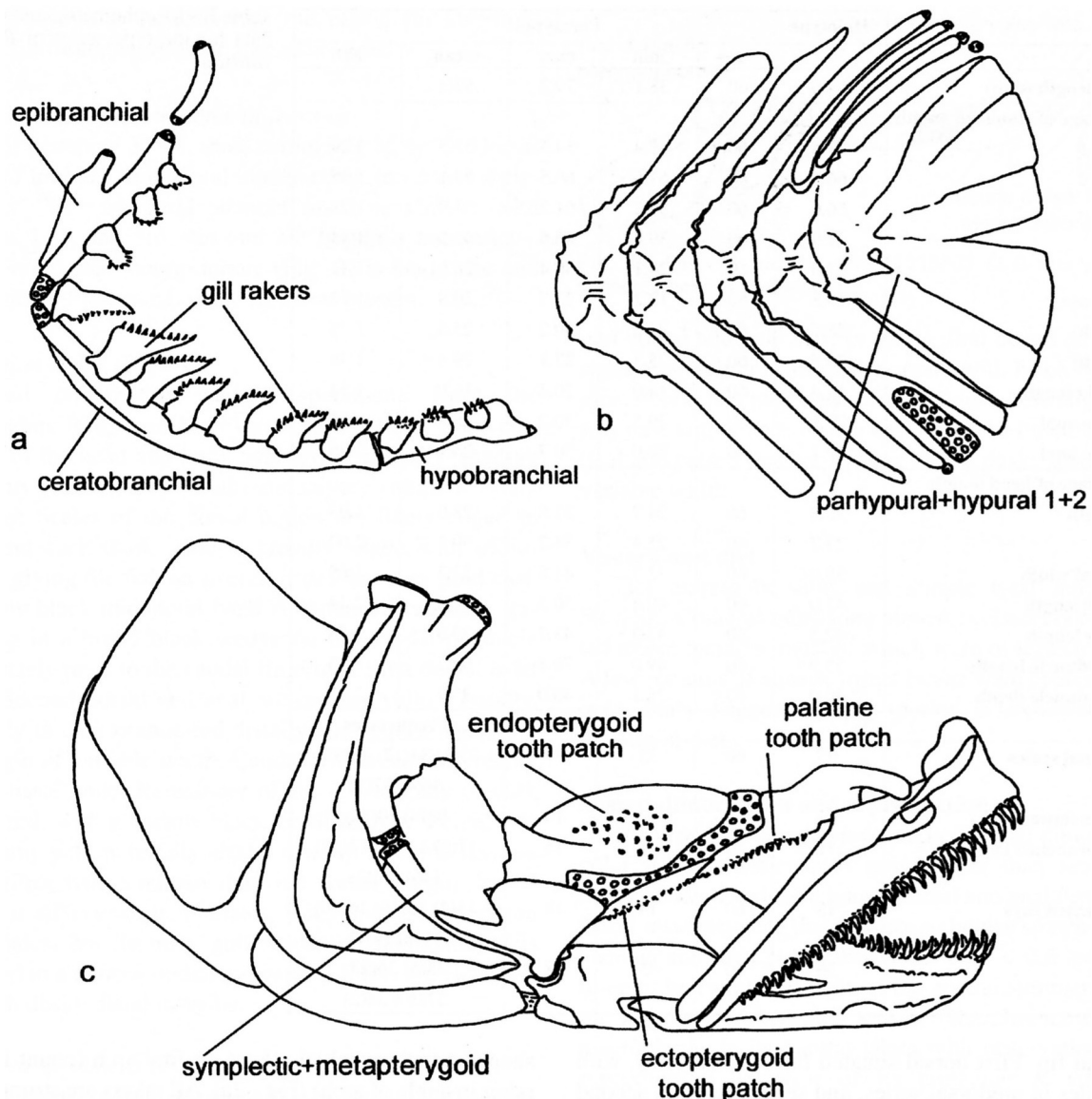


Fig. 2. - *Rheocles vatosoa*, AMNH 215502, 68.0 mm SL, lateral view of: a: first gill arch and rakers; b: caudal fin skeleton and associated vertebrae; c: oral jaws and suspensorium.

48.4-56.5 mm SL, (same data as AMNH 215502), MNHN 2001-1239, 2, 51.8-53.5 mm SL (same data as AMNH 231254), MRAC A1-037-P-1-2, 2, 46.8-54.0 mm SL (same data as AMNH 231366), UMMZ 238789, 2, 49.5-59.9 mm SL (same data as AMNH 231367).

Differential diagnosis

Rheocles vatosoa is unique among congeners in the possession of a single interdorsal pterygiophore (vs three; Fig. 3). It is readily distinguished from *R. sikorae* and *R. wrightae* by a shorter upper jaw (32.3-43.7 %HL vs 46.2-59.0), and absence of black pigmentation of genital papilla (vs strongly pigmented papillae), from *R. pellegrini* and *R. derhami* by full squamation of the nape and chest (vs

naked or partially scaled), from *R. lateralis* by a shorter caudal peduncle (49.0-79.8 %SL vs 84.6-96.0), and from *R. alaotrensis* by predorsal scale row implantation (irregular vs single row), and longer anal fin base (24.1-30.4 %SL vs 17.2-21.7 %SL).

Description

Morphometric and meristic data for the holotype and 60 paratypes are given in table I. Largest specimen a mature male (79.2 mm SL) with greatly enlarged testes filling abdominal cavity. Robust, deep-bodied (body depth 22.2-30.2 %SL) with somewhat rounded dorsal and ventral profiles. Greatest body depth situated at a vertical through origin of anal fin. First dorsal situated far back on body, with

	Holotype	Paratypes				
		n	min	max	mean	SD
Standard length (mm)	64.6	60	38.1	79.2	52.3	
In percentage of standard length						
Predorsal 1	53.5	60	48.4	54.5	51.5	1.24
Predorsal 2	66.5	60	61.6	66.5	64.1	1.36
Preanal	56.6	60	55.2	61.2	57.9	1.22
Prepelvic	42.9	60	39.4	46.6	42.5	1.44
Anal base	27.0	60	24.1	30.4	26.9	1.41
Dorsal 2 base	19.8	60	17.2	23.7	20.8	1.22
Body depth	28.7	60	22.2	30.2	25.5	1.73
Head length	30.5	60	25.3	32.1	29.4	1.38
Pectoral fin length	17.4	60	14.0	20.4	16.9	1.14
Dorsal 1 to anal	28.1	60	20.5	30.2	25.3	2.05
Dorsal 2 to anal	29.1	60	20.0	30.7	25.1	2.25
In percentage of head length						
Snout length	28.0	60	24.7	32.8	28.0	1.93
Eye depth	27.7	60	25.4	34.2	30.1	2.00
Interorbital width	39.0	60	33.7	41.8	37.3	1.65
Lower jaw length	47.0	60	40.4	50.5	46.5	2.14
Upper jaw length	42.3	60	32.3	43.7	39.5	2.38
Caudal peduncle length	55.9	60	49.0	79.8	63.2	6.53
Caudal peduncle depth	40.0	60	26.1	40.0	35.7	2.07
Frequencies						
Longitudinal scales	35	60	33	37	33(1) 34(17) 35(37) 36(4) 37(1)	
Gill rakers (lower arch)	10	60	9	10	9(48) 10(12)	
Dorsal 2 branched rays	11	60	11	15	11(6) 12(38) 13(10) 14(4) 15(2)	
Anal branched rays	15	60	14	18	14(4) 15(19) 16(30) 17(6) 18(1)	
Vertebrae	36	60	35	38	35(5) 36(23) 37(30) 38(2)	

Table I. - Morphometric and meristic data for the type series of *Rheocles vatosoa*.

19-23 scales in predorsal series, and separated from second dorsal by 2-3 scales. Second dorsal fin originates well behind anal origin. Dorsal head profile interrupted by premaxillary pedicel. Snout short and somewhat upturned mouth. Gape inclination approximately 40° to horizontal when mouth closed. Upper jaw extends to vertical through anterior portion of orbit.

Teeth

Jaws with 4 to 6 rows of numerous irregularly implanted small recurved unicuspid teeth with slight differentiation between outer and inner rows. A tooth row on palatine and ectopterygoid, and small tooth patch on metapterygoid (Fig. 2c). Vomerine teeth absent in all individuals examined.

Gill rakers

Two to 3 stout hypobranchial rakers, 6-8 robust, anvil-

shaped ceratobranchial rakers on first arch (count includes raker in angle of arch) (Fig. 2a). All rakers are strongly denticulate.

Scales

Body covered with moderately large imbricate, cycloid scales. Nineteen to 23 predorsal scales in irregular rows over midline. Nape, chest fully, and belly usually, scaled. Thirty three to 37 scales in longitudinal series. First and second dorsal fin separated by 2 to 3 scale rows. Cheek covered by two large scales, a few scattered scales on opercle. Caudal fin lightly scaled over base.

Fins

First dorsal with 4-6 weak spines. Second dorsal long-based (17.2-23.7 %SL) with a weak spine and 11-15 branched rays. Anal fin with weak spine and 14-18 branched rays. Pectoral fins high set, longest upper ray extends

beyond a vertical from the pelvic fin insertion. Caudal fin forked with broad, rounded lobes.

Osteology and other anatomical features

Total vertebrae 35-38, most commonly 36 or 37. Dorsal ramus of urohyal simple and unexpanded. In caudal skeleton (Fig. 2b) parhypural element fused proximally with hypurals 1+2, and 3rd, 4th and 5th hypurals autogenous. Single interdorsal pterygiophore (Fig. 3) is blade-like and unexpanded. Ethmo-maxillary ligament present.

Coloration in life (Fig. 4)

Based on freshly caught specimens from the Andramonta River and Marovato Creek. Males: Base coloration of the head and body pale brown dorsally, shading to creamy yellow on the flanks and silvery yellow to white ventrally. Scales of the dorsal region are finely edged in black and each flank scale is broadly edged with iridiophores, giving the fish an overall iridescent rosy gold cast. A narrow black midlateral band is expanded caudally, terminating in a broad black wedge on the caudal peduncle immediately prior to the caudal fin origin. First dorsal is jet black. Second dorsal and anal are creamy yellow basally, burgundy to dark orange-red distally and sport a black distal margin of variable width. Caudal with a narrow creamy yellow basal zone. Remainder of fin is burgundy to dark orange red, with a narrow black distal margin. Pelvic fins are creamy yellow basally, dusky distally. Pectoral fins are clear yellow with a narrow dark red dorsal margin. Iris of the eye is silvery white. Females: Body and eye coloration as in males, but the rosy gold structural pigmentation is restricted to a narrow midlateral band. All fins are clear yellow with dusky distal margins.

Preserved specimens (Fig. 1)

Base body color dusky, light yellow brown, darker dorsally with heavily pigmented scale edges. Midlateral stripe narrow anteriorly, increasingly thicker caudally and terminating in a broad wedge on base of the caudal peduncle. Origin of the midlateral stripe well in advance of the first dorsal fin. Thin line of dark pigment at the base of the sec-

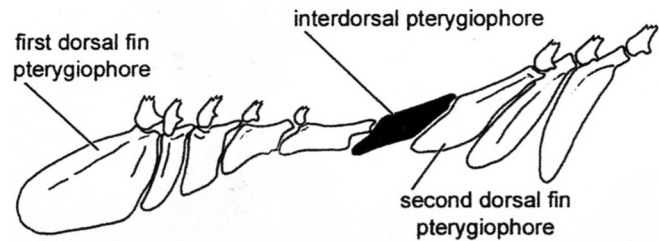


Fig. 3. - *Rheocles vatosoa*. AMNH 215502, 68.0 mm SL, skeletal support elements of dorsal fins.

ond dorsal and anal fins. In males, first dorsal dark brown, remaining vertical fins dusky cream with black distal margins. Pelvic fins pale cream basally, dusky distally. Pectoral fins pale with a dark brown basal spot. In females, the vertical and paired fins are hyaline with a dusky distal zone of variable width.

Viscera and diet

Gut extremely short and simple total length about 50 %SL. Contents consisting almost exclusively of macerated insect remains, most of which were of terrestrial origin. A few remains of aquatic insect larvae were present in some individuals, suggesting this species is somewhat opportunistic in diet.

Sexual dimorphism and reproduction

Rheocles vatosoa displays marked sexual dimorphism in color pattern. Males also grow larger than females, are deeper-bodied and have longer dorsal and anal fins (Fig. 1). Local residents state that *R. vatosoa* begins spawning in late October and early November. Specimens < 2.6 cm TL continue to be caught throughout the austral summer, suggesting a protracted breeding season. The absence of aquatic macrophytes in its habitat taken with observations on the reproductive behavior of its congener *R. alaotrensis* (Saunders, pers. com.) suggest that this species deposits demersal eggs in patches of coarse gravel.

Distribution and habitat (Figs 5-6)

The type series and all available specimens of *Rheocles*



Fig. 4. - *Rheocles vatosoa*, adult male. Aquarium held specimen from Marovato creek at Ambodivohitra village. (Photo P.V. Loisele).



Fig. 5. - Marovato creek (Lokoho River basin) at Ambodivohitra village, several kilometers past Marovato village on the road to Ambalamanagy (14°34'95"S, 49°37'74"E), from where the holotype was collected.

vatosoa have been collected in the upper and middle reaches of the Lokoho River in the general vicinity of the town of Andapa. Although apparently restricted to the Lokoho drainage, *R. vatosoa* has the widest altitudinal range so far recorded for any species of the genus, with specimens collected from as low as 157 m asl (Andrakata stream at Andrakata village; 14°37'64"S, 49°43'10"E) up to 940 m asl (Betsivakiana River, 14°49'29"S, 49°35'44"E). Throughout its range *Rheocles vatosoa* is found predominantly in clear streams over gravel or coarse sand bottoms. Such streams are characterized by soft, slightly acidic to moderately alkaline water, total and carbonate hardness values < 1°DH, electrical conductivity between 23 and 30 μ S/cm, and pH values between 6.8 and 7.5 (data for the Andrakata River and streams within the Andapa basin). The species was collected in substantial numbers from both

large, rapidly flowing rivers and small brooks. Whereas all collecting sites in the Andapa region were characterized by a shrubby riparian zone, none of the streams in question is located in an area of undisturbed forest.

Given that all *Rheocles* collected in the vicinity of Andapa have proven referable to *R. vatosoa*, the question of the provenance of the type series of Nichols and LaMonte's *R. pellegrini* should be addressed. Rand (1936) provides a map showing the itineraries of the various members of the Mission Zoologique Franco-Anglo-Américaine to Madagascar (1929-1932). The locality "One day West of Andapa" from whence came the type series of *R. pellegrini* indicated (Fig. 6) and would appear to lie in the adjacent Antanaimbalana drainage (possibly in the basin of the Ampariny River), rather than in either the Lokoho or the Ankavia-Ankavanana basin as had been previously assumed (Stiassny, 1990; Stiassny and Rodriguez, 2001).

Conservation status

Although it remains sufficiently abundant to support an artisanal basket fishery of the sort described by Kiener (1963), the numbers of the new species have declined substantially over the past half century. According to residents of villages in the Andapa region, *R. vatosoa* was formerly abundant throughout the basin. Consequent upon the complete replacement of aboriginal vegetation covering the floor of the Andapa basin with rice paddies, this species is now restricted to streams that drain the slopes of the surrounding mountains, which still retain a measure of forest cover. Ongoing deforestation and the presence of the exotic species *Gambusia holbrooki* and *Channa* cf. *striata* pose the principal threats to the long-term survival of *R. vatosoa*, which qualifies as "endangered" under the criteria established by the International Union for the Conservation of Nature (IUCN).

Etymology

The specific name *vatosoa*, the Malagasy word for crystal or gemstone, refers to the jewel-like coloration of living specimens. It is to be treated as a non-Latinized noun in apposition.

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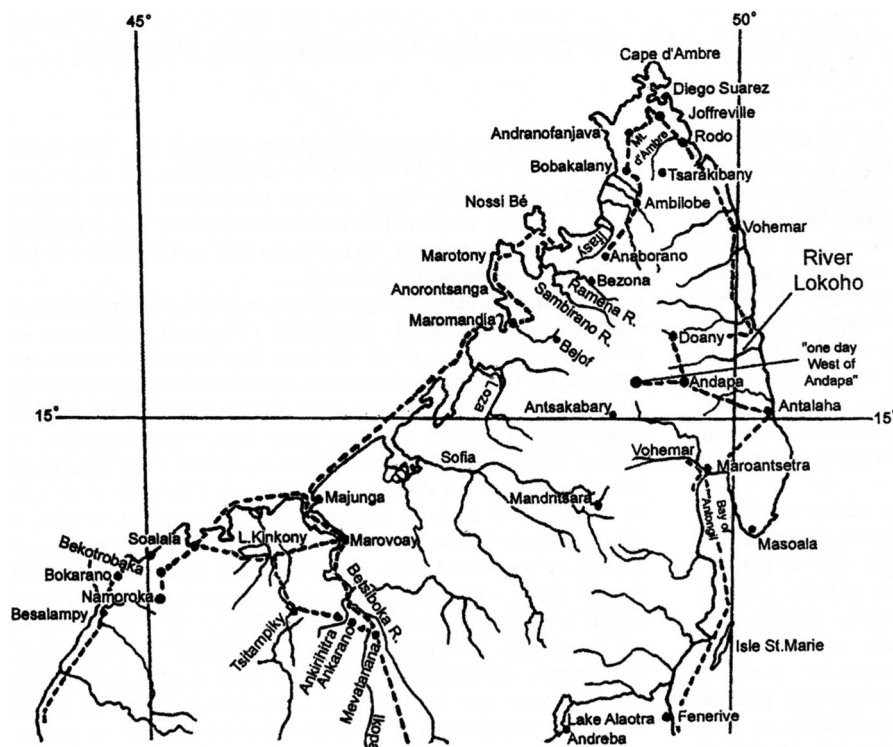


Fig. 6. - Map of northern region of Madagascar indicating routes (dashed lines) of members of the Mission Zoologique Franco-Anglo-Américaine to Madagascar (1929-1932). After Rand (1936).

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